1 219 066

PATENT SPECIFICATION

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DRAWINGS ATTACHED

(21) Application No. 47177 69 (22) Filed 25 Sept. 1969

(45) Complete Specification published 13 Jan. 1971

(51) International Classification H 03 h 9 06

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(54) IMPROVEMENTS IN OR RELATING TO ELECTROMECHANICAL FILTERS

ERRATUM

SPECIFICATION NO. 1,219,066

Page 1, Heading, Above (54) Title *insert* '(72) Inventor 'ZYGMUNT SEWERYN'

THE PATENT OFFICE
2 March 1971

R 529/9

smaller than and have a higher quality factor than the equivalent L-C network. However, electromechanical filters have the disadvantage that they have numerous unwanted modes of mechanical vibrations i.e. overtones and spurious responses.

The invention provides an electromechanical filter comprising one or a plurality of coupled flexural resonator elements, wherein the or each resonator element is supported at or near to a node associated with an operating mode of flexural vibrations, by means of a mounting arrangement including a bush of low quality factor material thereby causing attenuation of the modes of mechanical vibrations which are other than the operating mode, and which have a node or nodes at positions other than the position of the said node, and substantially zero attenuation of the operating mode.

The foregoing and other features according to the invention will be better understood from the following description with reference to the accompanying drawings, in which:

Figure 1 diagrammatically illustrates a pictorial view of an electromechanical filter according to the invention having a single resonator element.

Figure 2 diagrammatically illustrates a sectional end elevation on a model axis of the electromechanical filter according to Figure 1.

Figure 3 diagrammatically illustrates a sectional end elevation on a nodal axis of an alternative arrangement for the electromechanical filter according to Figures 1 and 2,

electromechanical filter according to the invention having a single resonator element 1 is diagrammatically illustrated therein in a pictorial view and a sectional end elevation respectively. The resonator element 1 which is a free vibrating flexural resonator element and preferably of metal is adapted to vibrate in bending oscillations in a direction perpendicular to the longitudinal axis of the filter. The resonator element 1 is connected to a ground plane member 2 by means of mounting members 3 which are each fitted into a bush 4 of a low quality factor material, for example a low quality factor rubber. The bushes 4 are each secured in the resonator element 1 at or near to a node thereof i.e those regions of the resonator element 1 in which the displacement during oscillations at an operating node of mechanical vibrations is a minimum, by providing a hole in the resonator element which is such that its axis is coaxial with or parallel to the axis of the node and which is of a diameter such that the mounting member with the bush thereon is a tight fit therein. The mounting members 3 are secured at each end to the ground plane member 2, by either soldering or spot welding. The mounting members 3 can consist of ribbons, strips or the like.

Since a low quality factor mounting is utilized, the modes of mechanical vibrations which are other than the operating mode and which have a node or nodes at positions other than the position of the nodes associated with the operating mode, are attenuated due to the damping effects of the low quality factor bushes 4. The attenuation of the operating mode is however substantially zero. A robust

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(54) IMPROVEMENTS IN OR RELATING TO ELECTROMECHANICAL FILTERS

(71) We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of 190 Strand, London, W.C.2, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an electromechanical filter.

In general, electromechanical filters are smaller than and have a higher quality factor than the equivalent L-C network. However, electromechanical filters have the disadvantage that they have numerous unwanted modes of mechanical vibrations i.e. overtones and spurious responses.

The invention provides an electromechanical filter comprising one or a plurality of coupled flexural resonator elements, wherein the or each resonator element is supported at or near to a node associated with an operating mode of flexural vibrations, by means of a mounting arrangement including a bush of low quality factor material thereby causing attenuation of the modes of mechanical vibrations which are other than the operating mode, and which have a node or nodes at positions other than the position of the said node, and substantially zero attenuation of the operating mode.

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Figure 3 diagrammatically illustrates a sectional end elevation on a nodal axis of an alternative arrangement for the electromechanical filter according to Figures 1 and 2,

Figure 4 diagrammatically illustrates a sectional end elevation on a nodel axis of an electromechanical filter according to the invention having a plurality of resonator elements, and

Figure 5 diagrammatically illustrates a sectional end elevation on a nodel axis of a further alternative arrangement for the electromechanical filter according to Figures 1 and 2.

Referring to Figures 1 and 2, an electromechanical filter according to the invention having a single resonator element 1 is diagrammatically illustrated therein in a pictorial view and a sectional end elevation respectively. The resonator element 1 which is a free vibrating flexural resonator element and preferably of metal is adapted to vibrate in bending oscillations in a direction perpendicular to the longitudinal axis of the filter. The resonator element 1 is connected to a ground plane member 2 by means of mounting members 3 which are each fitted into a bush 4 of a low quality factor material, for example a low quality factor rubber. The bushes 4 are each secured in the resonator element 1 at or near to a node thereof i.e those regions of the resonator element 1 in which the displacement during oscillations at an operating node of mechanical vibrations is a minimum, by providing a hole in the resonator element which is such that its axis is coaxial with or parallel to the axis of the node and which is of a diameter such that the mounting member with the bush thereon is a tight fit therein. The mounting members 3 are secured at each end to the ground plane member 2, by either soldering or spot welding. The mounting members 3 can consist of ribbons, strips or the like.

Since a low quality factor mounting is utilized, the modes of mechanical vibrations which are other than the operating mode and which have a node or nodes at positions other than the position of the nodes associated with the operating mode, are attenuated due to the damping effects of the low quality factor bushes 4. The attenuation of the operating mode is however substantially zero. A robust

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construction is therefore provided which renders the resonator element less sensitive to ambient vibrations and shocks.

An alternative arrangement for the low quality factor mounting is diagrammatically illustrated in Figure 3 of the drawings in a sectional end elevation. This arrangement of the electromechanical filter is basically the same as the electromechanical filter according to Figures 1 and 2 except that two bushes 5 of low quality factor material, for example a low quality factor rubber are provided in the ground plane member 2, at or near to each node position, into each one which is fitted a mounting member 6 that is secured at one end at or near to the node of the resonator element by either soldering or spot welding. Alternatively a single mounting member could be utilized in place of the members 6 at each node position by passing it through and securing it to the resonator element.

The low quality factor mounting illustrated in Figures 1 and 2 can be adapted, as illustrated in Figure 4 of the drawings, to mount a plurality of co-planar resonator elements 1 without having to rely on the coupling elements (not shown) for structural support. It will of course be appreciated that the three bushes 4 could be replaced by a single bush that extends along the total working length of the mounting member 3.

In the case of low frequency electromechanical filters which utilize relative thin resonant elements, the low quality factor mounting according to Figures 1 and 2 is not practical since the resonator elements are not thick enough to house the bush of low quality factor material and the associated mounting member. Thus, for low frequency electromechanical filters the mounting arrangement diagrammatically illustrated in Figure 5 of the drawings is utilized. This mounting arrangement is basically the same as the mounting arrangement according to Figures 1 and 2 from both the structural and the operational aspects, the only structural difference being that the bush 4 and the mounting member 3 at or near to each node position of the resonator element 1 are transverse to the axis 7 of the node.

WHAT WE CLAIM IS:—

1. An electromechanical filter comprising one or a plurality of coupled flexural resonator elements, wherein the or each resonator element is supported at or near to a node associated with an operating mode of flexural vibrations, by means of a mounting arrangement including a bush of low quality factor material thereby causing attenuation of the modes of mechanical vibrations which are other than the operating mode and which have a node or nodes at positions other than the position of the said node, and substantially zero attenuation of the operating mode.

2. An electromechanical filter as claimed in claim 1 wherein the said bush is secured in the resonator element at or near to the said node, and said mounting arrangement further includes a mounting member which is connected to a ground plane and which is fitted into the said bush.

3. An electromechanical filter as claimed in claim 2 wherein the bush extends over a portion only of the length of the mounting member.

4. An electromechanical filter as claimed in either claim 2 or claim 3 wherein the mounting member is coaxial with or parallel to the axis of the said node.

5. An electromechanical filter as claimed in either claim 2 or claim 3 wherein the mounting member is transverse to the axis of the said node.

6. An electromechanical filter as claimed in claim 4 wherein when a plurality of co-planar resonator elements are utilized the mounting member extends through the bush associated with each of the resonator elements.

7. An electromechanical filter as claimed in claim 1 wherein a said bush is provided at each ground plane mounting position, and said mounting arrangement further includes, for each said bush, a mounting member that is fitted into the bush and is connected to the resonator element at or near to the said node in a manner such that it is coaxial with or parallel to the axis of the said node.

8. An electromechanical filter as claimed in any one of the claims 1 to 7 wherein the low quality factor material is rubber.

9. An electromechanical filter as claimed in any one of the claims 2 to 8 wherein the mounting member is of circular cross-section.

10. An electromechanical filter substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

11. An electromechanical filter substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

12. An electromechanical filter substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

13. An electromechanical filter substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.

S. R. CAPSEY,
Chartered Patent Agent
for the Applicant.

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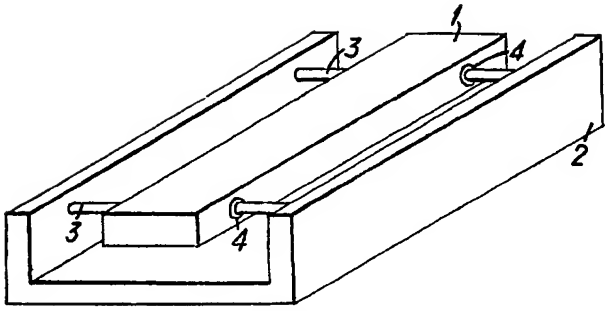

Fig.1.

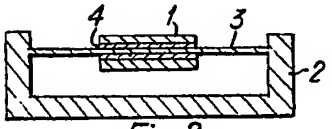

Fig.2.

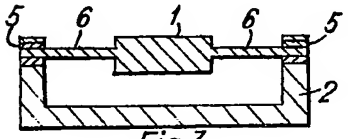

Fig.3.

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Sheet 2

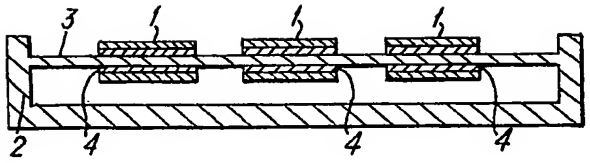

Fig.4.

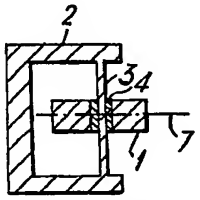

Fig.5.

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Since a low quality factor mounting is utilized, the modes of mechanical vibrations which are other than the operating mode and which have a node or nodes at positions other than the position of the nodes associated with the operating mode, are attenuated due to the damping effects of the low quality factor bushes 4. The attenuation of the operating mode is however substantially zero. A robust

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The low quality factor mounting illustrated in Figures 1 and 2 can be adapted, as illustrated in Figure 4 of the drawings, to mount a plurality of co-planar resonator elements 1 without having to rely on the coupling elements (not shown) for structural support. It will of course be appreciated that the three bushes 4 could be replaced by a single bush that extends along the total working length of the mounting member 3.

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WHAT WE CLAIM IS:—

1. An electromechanical filter comprising one or a plurality of coupled flexural resonator elements, wherein the or each resonator element is supported at or near to a node associated with an operating mode of flexural vibrations, by means of a mounting arrangement including a bush of low quality factor material thereby causing attenuation of the modes of mechanical vibrations which are other than the operating mode and which have a node or nodes at positions other than the position of the said node, and substantially zero attenuation of the operating mode.

2. An electromechanical filter as claimed in claim 1 wherein the said bush is secured in the resonator element at or near to the said node, and said mounting arrangement further includes a mounting member which is connected to a ground plane and which is fitted into the said bush.

3. An electromechanical filter as claimed in claim 2 wherein the bush extends over a portion only of the length of the mounting member.

4. An electromechanical filter as claimed in either claim 2 or claim 3 wherein the mounting member is coaxial with or parallel to the axis of the said node.

5. An electromechanical filter as claimed in either claim 2 or claim 3 wherein the mounting member is transverse to the axis of the said node.

6. An electromechanical filter as claimed in claim 4 wherein when a plurality of co-planar resonator elements are utilized the mounting member extends through the bush associated with each of the resonator elements.

7. An electromechanical filter as claimed in claim 1 wherein a said bush is provided at each ground plane mounting position, and said mounting arrangement further includes, for each said bush, a mounting member that is fitted into the bush and is connected to the resonator element at or near to the said node in a manner such that it is coaxial with or parallel to the axis of the said node.

8. An electromechanical filter as claimed in any one of the claims 1 to 7 wherein the low quality factor material is rubber.

9. An electromechanical filter as claimed in any one of the claims 2 to 8 wherein the mounting member is of circular cross-section.

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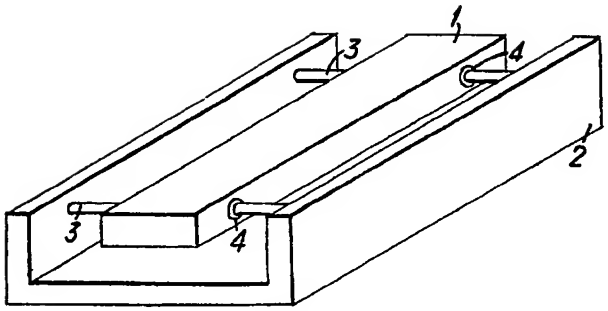

Fig. 1.

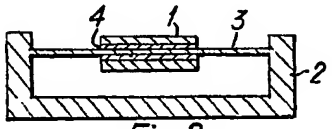

Fig. 2.

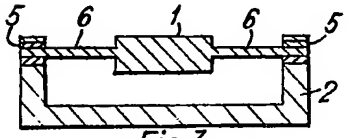

Fig. 3.

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Sheet 2

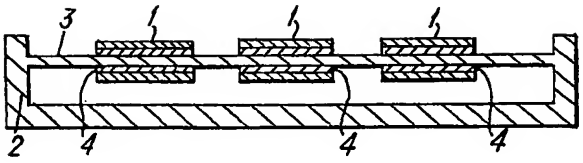

Fig.4.

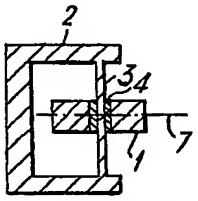

Fig.5.